

CLAIMS:-

- 5 1. A composition of matter comprising
(a) a metal powder,
(b) a solder powder which melts at a lower
temperature than the metal powder,
(c) a polymer, or a monomer which is
polymerisable to yield a polymer, a said polymer
being crosslinkable under the action of a chemical
10 cross-linking agent,
(d) a crosslinking agent for said polymer, the
crosslinking agent having fluxing properties and
being nonreactive with said polymer without the
application of heat and provision of a catalyst
15 for reaction therebetween, the crosslinking agent,
as such not reacting with said polymer under
storage conditions, and the crosslinking agent
being capable of solvating
(e) metallic oxide and metallic salt catalysts
20 which are formed by heating metallic components
(a) and (b) and which promote a rapid crosslinking
reaction between said polymer (c) and said
crosslinking agent (d) when incorporated in said
polymer, as a result of solvation by the
25 crosslinking agent in the presence of heat.
- 30 2. A composition according to Claim 1, wherein said
metal powder is selected from Au, Ag, Cu, Zn, Al, Pd,
Pt, Rh, Fe, Ni, Co, Mo, W, Be, and alloys thereof.
3. A composition according to Claim 2 wherein said
metal powder is copper.
- 35 4. A composition according to Claim 1, ~~2 or 3~~,
wherein said solder powder is selected from Sn, Bi, Pb,
Cd, Zn, Ga, In, Te, Hg, Sb, Se, Tl and alloys thereof.

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5. A composition according to Claim 4 wherein said solder powder alloy is Sn63Pb37.

aa 5 6. A composition according to ~~any preceding claim~~ wherein said cross-linking agent is selected from carboxylated polymers, dimer fatty acids, and trimer fatty acids.

10 7. A composition according to Claim 6 wherein said cross-linking agent is a styrene-acrylic acid copolymer, and/or an organic trimer acid having a functionality greater than 1.

aa 15 8. A composition according to ~~any preceding claim~~ wherein said catalyst is formed by heating and oxidation of solder powder and dissolved by the fluxing agent.

20 9. A composition according to Claim 8 wherein said catalyst is a metallic oxide catalyst formed by heating and oxidation of tin and/or lead powder and dissolved by the fluxing agent.

25 10. A composition according to Claim 1 wherein said catalyst is a metallic salt catalyst formed by heating and oxidation of metal powder or solder powder to form a metallic oxide and reaction of the metallic oxide with resin or solvent to produce organo-metal salts.

30 11. A composition according to Claim 10 wherein said catalyst is a tin salt catalyst formed by heating tin to form a tin oxide and reaction of the latter with resin or solvent to produce tin salt.

35 12. A composition according to Claim 10 wherein said catalyst is a copper salt catalyst formed by heating copper to form a copper oxide and reaction of the

latter with resin or solvent to produce a copper salt.

13. A composition according to any preceding claim,
wherein an organic chelating agent is adhered to the
metal powder as stability enhancer and the organic
chelating agent decomposes at solder melting
temperature to provide decomposition products which
dissolve in the fluxing agent as additional catalyst
for the chemical crosslinking agent.

14. A composition according to Claim 13 wherein said
organic chelating agent is an azole chelating agent.

15. A composition according to claim 13 wherein said
organic chelating agent is benzotriazole.

16. A composition according to any preceding claim
further comprising a copper salt deactivator as a
stability enhancer.

17. A composition according to Claim 16 wherein said
copper salt deactivator is oxalyl bis benzylidene
hydrazine.

18. A composition on, or for application to, a
dielectric substrate in a predetermined pattern
comprising, in admixture:

- (i) a metallic powder component which includes (a)
a solder powder and (b) a metal powder melting at
a higher temperature than the solder powder; and
- (ii) a polycarboxyl compound effective as a
fluxing agent for the metallic powder component at
a first temperature and as a cross-linking agent
for an epoxy resin at a higher second temperature,
the polycarboxyl compound being in contact with
such epoxy resin.

19. A composition according to claim 18 which has the epoxy resin in admixture with the metallic powder constituent and the polycarboxyl compound.

20. A composition according to claim 18, which has the epoxy resin pre-applied to the dielectric substrate.

21. A composition according to claim 19, wherein the epoxy resin is printed on the substrate in a predetermined pattern.

22. A composition according to ~~any one of claims 18 to 21~~, wherein the polycarboxyl compound is thermally stable to 215°C and has an acid number greater than 200 and a viscosity less than 0.01 Pa.s (10 centipoise) at 200°C.

23. A composition according to any one of claims 18-22, wherein the polycarboxyl compound is selected from: carboxylated polymers, polycarboxylic acids and polymer fatty acids.

24. A composition according to claim 23, wherein the polymer fatty acid is a dimer or trimer fatty acid.

25. A composition according to claim 23, wherein the carboxylated polymer is a styrene-acrylic acid copolymer.

26. A composition according to ~~any one of claims 18 to 25~~, wherein the metal powder component contains up to 90% by weight of metal powder (b) and from <100 to 10% by weight of the solder powder.

27. A composition according to ~~any one of claims 18 to 26~~, wherein metal powder (b) is a metal selected from Au, Ag, Cu, Zn, Al, Pd, Pt, Rh, Fe, Ni, Co, Mo, W, Be,

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and alloys thereof.

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aa 28. A composition according to ~~any one of claims 18 to~~
aa 27, wherein the solder powder is selected from Sn, Bi,
5 Pb, Cd, Zn, Ga, In, Te, Hg, Sb, Se, Tl and alloys
thereof.

25
aa 29. A composition according to ~~any one of claims 18 to~~
aa 28, wherein the solder powder includes a first metal
10 and a second metal, with the first metal having an
affinity for the high melting point constituent, an
oxide of the second metal being a catalyst for the
curing of the epoxy resin and the first and second
15 metals being melted together to form a metal film in
which is embedded particles of the high melting point
constituent while the first and second molten metals
form a matrix in regions between the particles of the
high melting point constituent, which matrix is rich in
20 the second metal of the relatively low melting point
constituent.

30. A composition according to claim 29, wherein the
solder powder is a tin/lead alloy.

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B 31. A composition according to claim 29 ~~or 30~~, wherein
metal powder (b) is copper.

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aa 32. A composition according to ~~any one of claims 18 to~~
aa 31, wherein the metallic powder component has particles
30 of a size less than 25µm.

29
aa 33. A composition according to ~~any one of claims 18 to~~
aa 32, wherein the epoxy resin consists essentially of an
epoxy resin which is liquid at ambient temperature.

35
aa 34. A composition according to ~~any one of claims 18 to~~
aa 33, which contains, in percent by weight, from 5 to 50%

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in total of epoxy resin and polycarboxyl compound and 95 to 50% of the metallic powder component.

aa ³¹
35. A composition according to ~~any one of claims 18 to~~
34 wherein metal powder (b) is a copper powder which
has been cleaned and coated with a stability enhancing
copper deactivator which is a chelation agent for the
copper and a high temperature catalyst for the
crosslinking of the epoxy resin.

10 ³²
36. A composition according to claim ³¹35, wherein the
chelation agent is an azole compound.

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37. A composition according to claim 36, wherein the
chelation agent is benzotriazole.

20 ^{aa} ³⁴
38. A composition according to ~~any one of claims 18 to~~
37, wherein metal powder (b) is copper powder and the
composition additionally includes anti-oxidant copper
deactivating agent.

25 ^{pub B6}
39. A composition according to claim 38, wherein the
anti-oxidant copper deactivating agent is oxalyl bis
benzylidene hydrazine.

30 ^{pub B3}
40. A method of making an electrically conductive
circuit on a dielectric surface comprising patterning a
dielectric substrate with the admixture of metallic
powder component and polycarboxyl compound as specified
in claim 18 with the epoxy resin of claim 18 either
being pre-coated on the substrate, or the epoxy resin
being incorporated in the patterned composition, and
heating the dielectric substrate thus patterned to a
temperature above the melting point of the solder metal
but below the melting point of metal powder (b), being
a temperature at which the polycarboxyl compound is
thermally stable but able to act as a fluxing agent to

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all achieve metallic sintering and catalyzed crosslinking
of the epoxy resin.

aa 41. The method of claim 40, wherein the epoxy resin ^{has been} is
5 pre-coated on the dielectric surface by patterning and
the composition is applied to the epoxy resin pattern
by matching patterning.

10 42. A method as claimed in claim 41, wherein the epoxy
resin is pre-coated on the dielectric substrate, a
photoimageable layer is applied to the adhesive layer,
the photoimageable layer is subjected to a photoimaging
and developing process to form a channel pattern in the
15 photoimageable layer corresponding to the circuit, said
admixture is introduced into the channel pattern and
the dielectric substrate is heated to said temperature
to achieve metallic sintering and substantial
crosslinking of the epoxy resin.

20 43. A method as claimed in claim 40, wherein a
photoimageable layer is applied to the dielectric
substrate and subsequently subjected to a photoimaging
and developing process to form a channel pattern, said
admixture additionally containing the epoxy resin is
25 introduced into the channel pattern and the dielectric
substrate is heated to said temperature to achieve
metallic sintering and substantial crosslinking of the
epoxy resin.

30 44. A method as claimed in 43 wherein the epoxy resin
is coated into the channel of the dielectric substrate
and "B" staged prior to the application of the
admixture.

aa 35 45. A method as claimed in claim ⁴⁰ ~~42, 43 or 44~~, wherein
the track is formed with an undercut region in side
walls thereof.

46. A method as claimed in 40 wherein the epoxy resin is applied to the entire dielectric substrate and "B" staged to produce a dry handleable substrate allowing for subsequent patterning of said admixture to said substrate.

47. A method for the production of an electrically conductive circuit which comprises patterning on a substrate, a composition according to ~~any one of claims 1 to 39~~ followed by heating of the composition to a temperature sufficient to melt the solder powder and coalesce the metallic film produced, to produce a metal film upon the dielectric substrate and adhesively adhered thereto by a cured and cross-linked epoxy resin.

48. A method of making a multilayered electrically conductive circuit by first applying and curing an insulating dielectric layer on a single layer electrically conductive circuit produced according to the method claimed in ~~any one of claims 40 to 46~~ the insulating dielectric layer having vias, and forming a second electrically conductive circuit on the cured dielectric layer by the method claimed in any one of claims 40 to 47 and repeating these steps to form a required plurality of alternating dielectric layers and electrically conductive circuit layers.

49. A method according to claim 48, wherein said vias are filled with a metal filling resulting from filling them with a composition according to any one of claims 18 to 39 having the epoxy resin contained therein and heating to a temperature sufficient to melt the solder metal, coalesce the metals present, cure the epoxy resin and cause the via filling to adhere to the via walls.

50. A method for the production of a multilayer printed wiring board in which electrically conductive circuits on substrates are laid over each other, which substrates include therein vias interconnecting the circuits, in which method the vias are filled with a composition according to ~~any one of claims 18 to 39~~ having the epoxy resin contained therein and the resulting assembly is heated to a temperature sufficient to melt the solder powder, coalesce the metallic film, cure the epoxy resin and cause the via filling to adhere to the via walls.

51. A method for the provision of a thermal transfer pillar in a semi-conductor package and/or a multichip module, which comprises depositing a composition as claimed in ~~any one of claims 18 to 39~~ having the epoxy resin incorporated as a polymer thick film at a location on said package and/or module at a location at which thermal transfer is required and heating the composition in-situ to a temperature sufficient to melt the solder metal but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial crosslinking of the epoxy resin.

52. A method for the provision of an electrically conductive termination on a printed potentiometer track, which comprises applying a composition as claimed in ~~any one of claims 18 to 39~~ having epoxy resin incorporated therein to the potentiometer track as a polymer thick film and heating the composition in-situ to a temperature above the melting point of the solder powder but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial crosslinking of the

epoxy resin.

53. A method of joining leads on a printed circuit board, or other substrate, usually for the purpose of repair or modification, which comprises applying a composition as claimed in ~~any one of claims 18 to 39~~ having the epoxy resin incorporated therein to a substrate at a predetermined location as a polymer thick film to and heating the composition in situ to a temperature above the melting point of the solder metal but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial complete crosslinking of the epoxy resin.

54. A method for the production of a shield layer on a multilayer printed wiring board for suppressing of electromagnetic interference or radio-frequency interference, which comprises depositing a composition as claimed in ~~any one of claims 18 to 39~~ having epoxy resin incorporated therein on a said wiring board and heating the composition in-situ to a temperature above the melting point of the solder metal but below the melting point of metal powder (b), being a temperature at which the polycarboxyl compound is thermally stable, to achieve metallic sintering and substantial crosslinking of the epoxy resin.

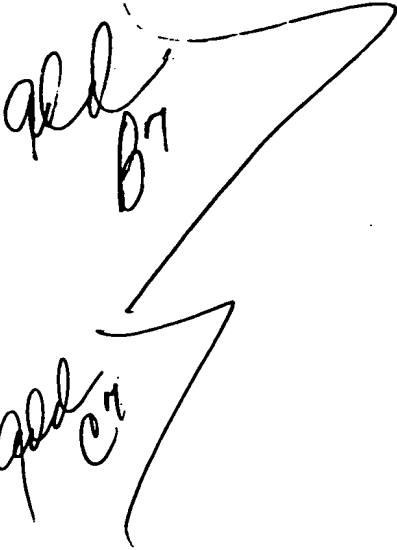
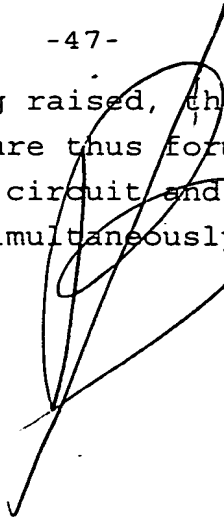
55. A method of joining electronic components to substrates whereby the composition as claimed in ~~any one of claims 1 to 39~~ is used as an electrically conductive adhesive to adhere the electric components to a said substrate.

56. A method as described in Claim (56), where the substrate has been produced by a method as claimed in ~~any of claims 40 to 46, 48 and 49~~ and the electronic components are placed into the said composition prior

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to the temperature being raised, the substrate is then heated to said temperature thus forming the electrically conducting circuit and joining the electronic components simultaneously to an electrically conductive circuit.

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